Distributed Mapping of SNTHERM-Modelled Snow Properties for Monitoring Seasonal Freeze/Thaw Dynamics

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Regional scale approaches for integrating land surface process modelling with remote sensing techniques at high latitudes are important because of the sparse distribution of ground stations in boreal/arctic regions. Many snow process studies use the 1-D mass and energy balance model SNTHERM, because the model is robust in process detail. It calculates the components of the surface energy exchange, snow density, grain size, liquid water and temperature in all snow layers. Previous work integrated SNTHERM with a canopy model, to predict and validate the stand scale effects of forest canopy on the snow surface energy exchange. This work extended the stand scale modelling effort to a regional scale across a portion of central Saskatchewan, Canada. Our approach involved creating a landscape classification map representing 54 unique landscapes based on tree species, height, and canopy closure in our 70 by 80-km modelling area. We ran the integrated snow-canopy model for each landscape class using unique initialization parameters and temporal drivers. Processed model output allowed us to distribute the results for each time step from February 23rd through May 1st 1994. Modelled snow properties distributed and mapped over the region include depth, albedo, temperature, density, liquid water, and grain size. We integrated this regional-scale modelling of snow properties with ERS SAR data, which allowed accurate assessment of landscape freeze/thaw dynamics for this region. One goal of this study was to quantify the effect of the melting snowpack on the SAR backscatter temporal dynamics, relative to the effect of soil and vegetation thaw. Significant changes in SAR backscatter occurred between March 1 and 4 as widespread thaw occurred over the region, followed by a freezing event between March 4 and 7. The observed backscatter correlated with changes in modelled snow surface properties. Fusing remote sensing data with snow models allowed characterization of spatial and temporal snowpack dynamics with maps depicting estimates of frozen landscape, thawed landscape, and open water.

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